Validation status report; CO from MLS in the middle atmosphere
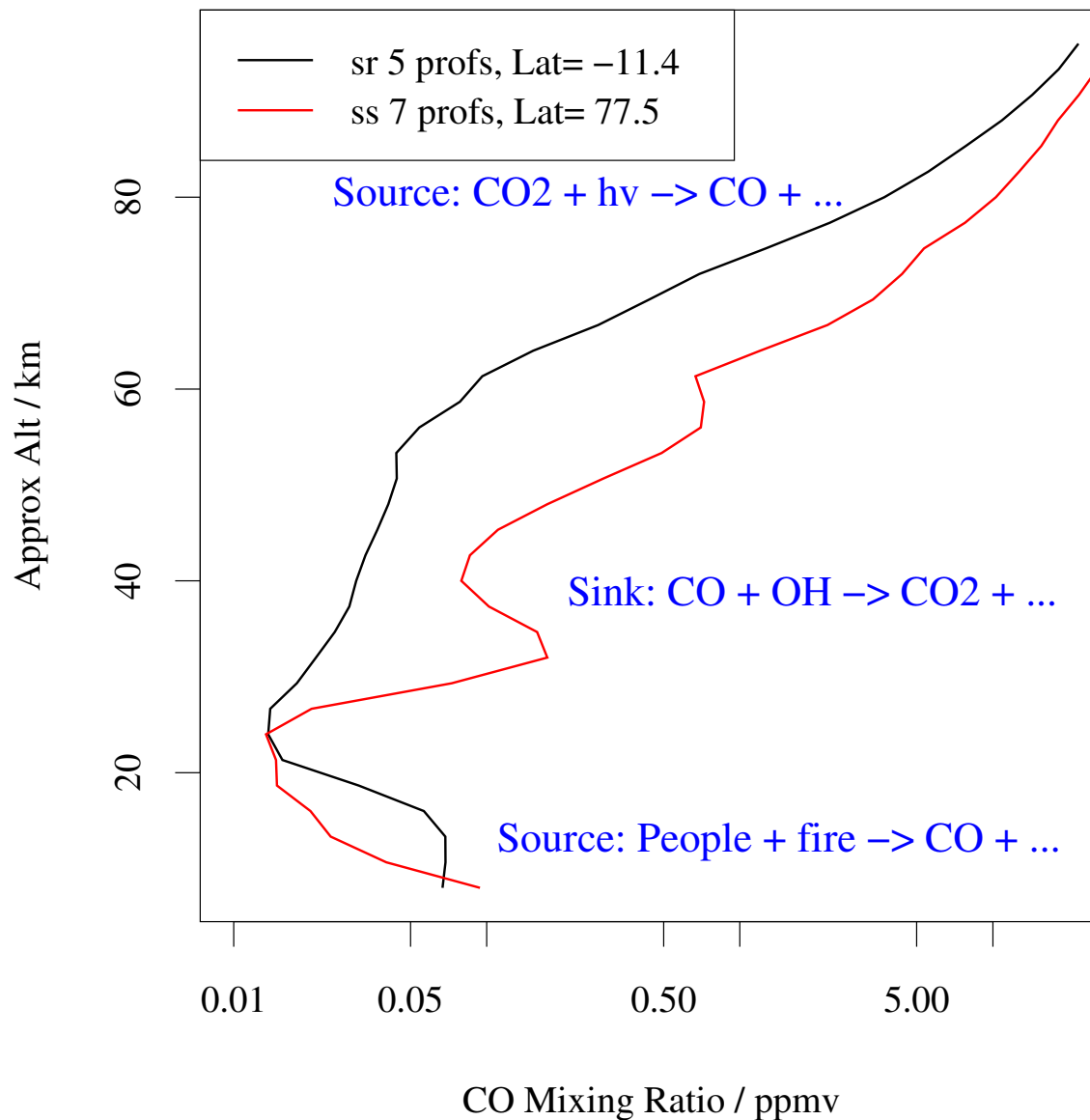
Hugh C. Pumphrey, Bob Harwood

with thanks to the MLS, ACE-FTS and ODIN-SMR teams

September 6, 2006

Middle Atmosphere CO

- Data are daily means from ACE-FTS, from 2005d053. Sunrise in black, sunset in red.

- Mixing ratio varies rapidly with height (note log scale)

- Descent in polar vortex brings higher values downwards (red profile)

- very little CO in lower stratosphere

- We only consider CO above stratospheric minimum

- Troposphere covered in following talk

How MLS measures CO
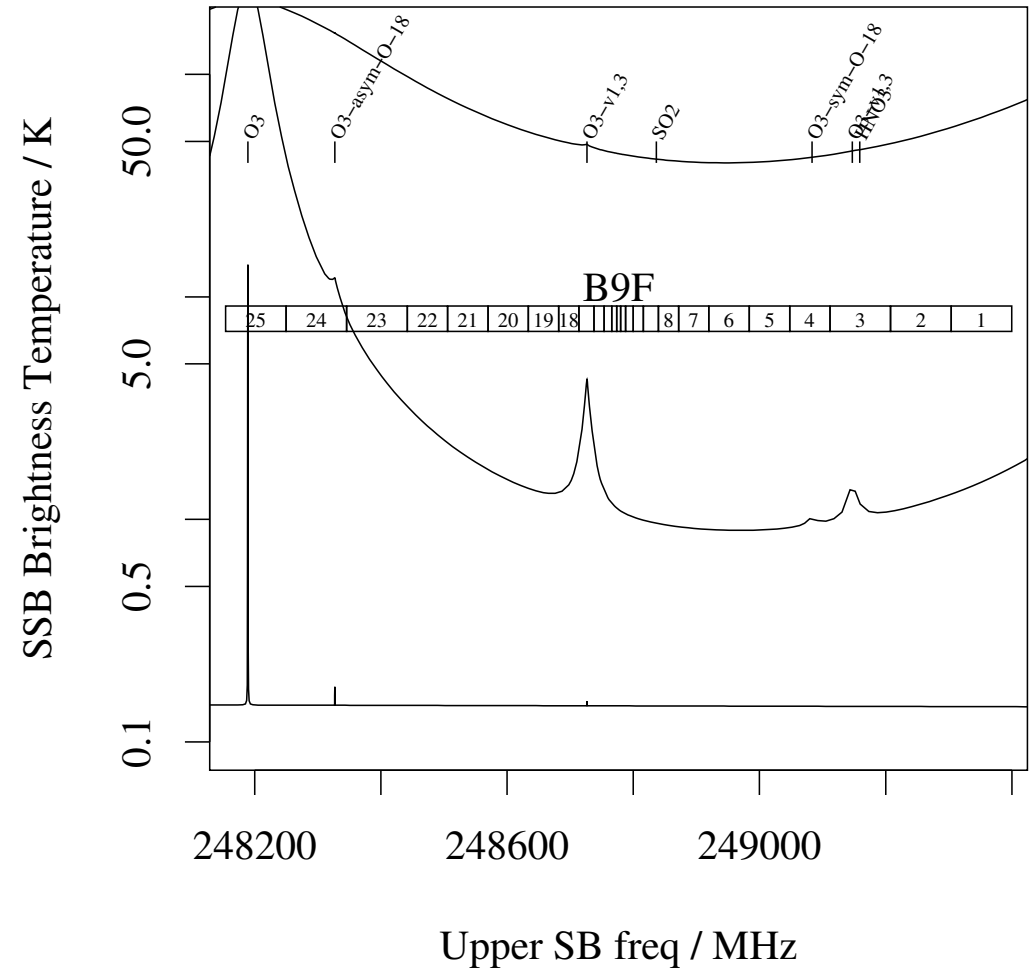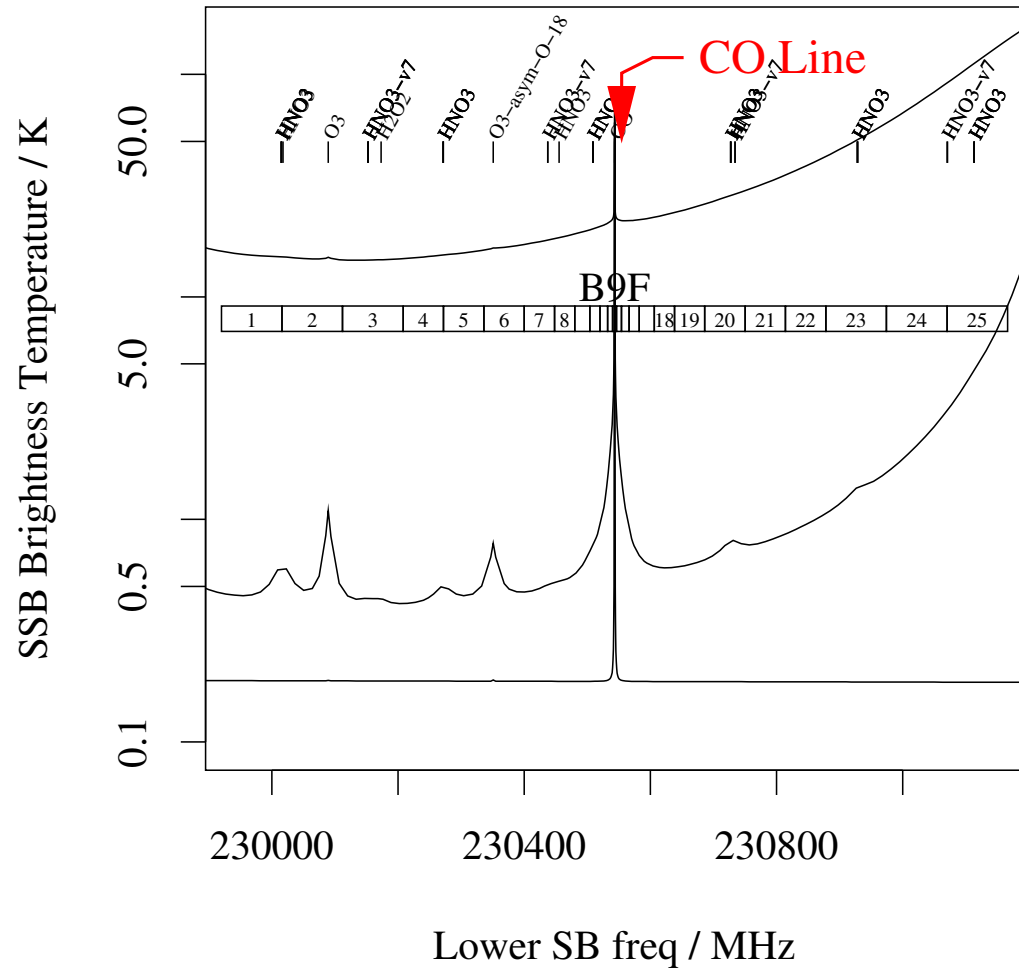
- Curves are radiance at 20, 35 and 80 km tangent height

- Double sideband radiometer. CO spectral line in lower sideband

- 25 Channel filter bank (B9F) centred on line

- 129-channel DACS (B25D) also centred on line (12.5MKz wide — too narrow to be shown on figure)

The MLS CO product
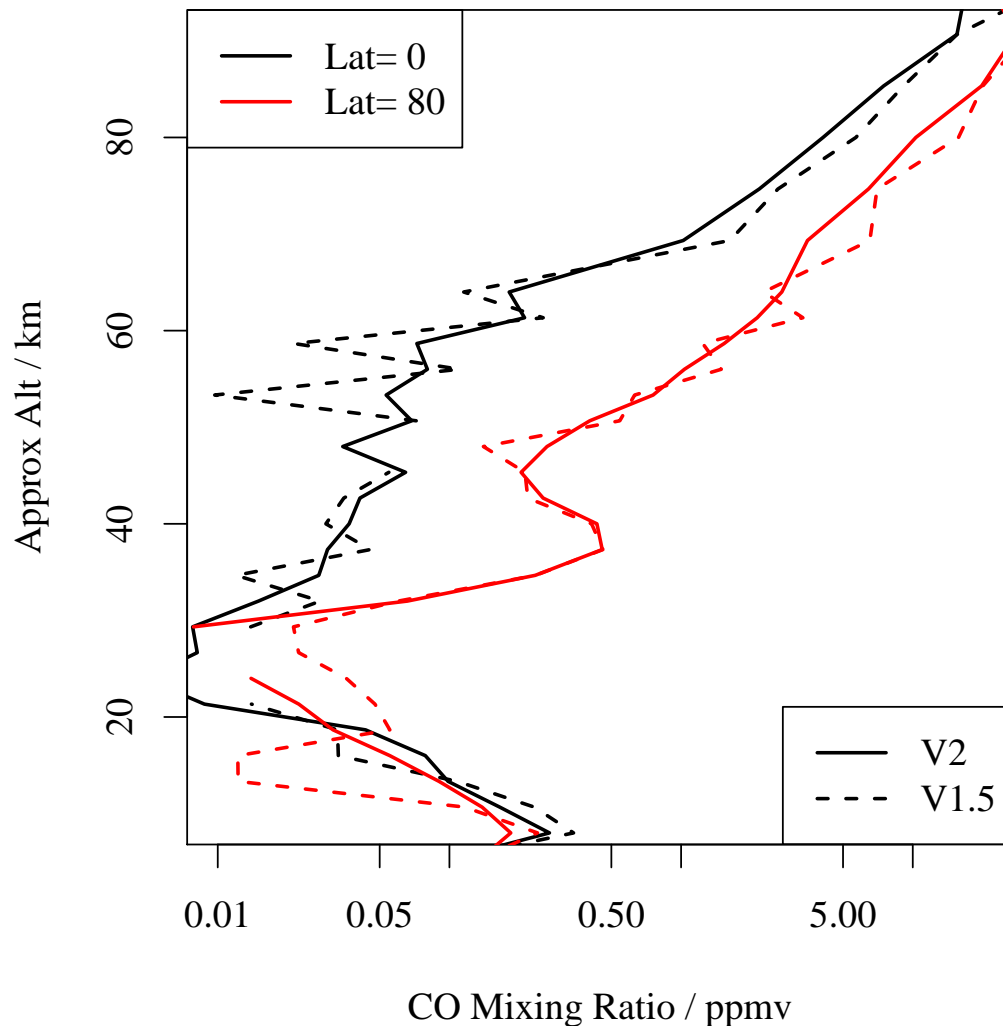
- Data shown are daily zonal means in 10° bins, for 2005d028.
- Current version (V1.5x − dashed lines) rather jagged and biased. All mission to date processed.
- New version (V2.x − solid lines) in final testing. Several days processed.
- Validation paper will describe V2.x
- Accuracy and resolution still being assessed

Validation

- Internal consistency

  - Residuals: Are retrieved profiles consistent with radiances?

- Consistency with other measurements

  - Other CO measurements

    * ACE-FTS

    * Odin-SMR

  - Dynamical data etc.

ZM Radiances (left) and Residuals (right): Band 9
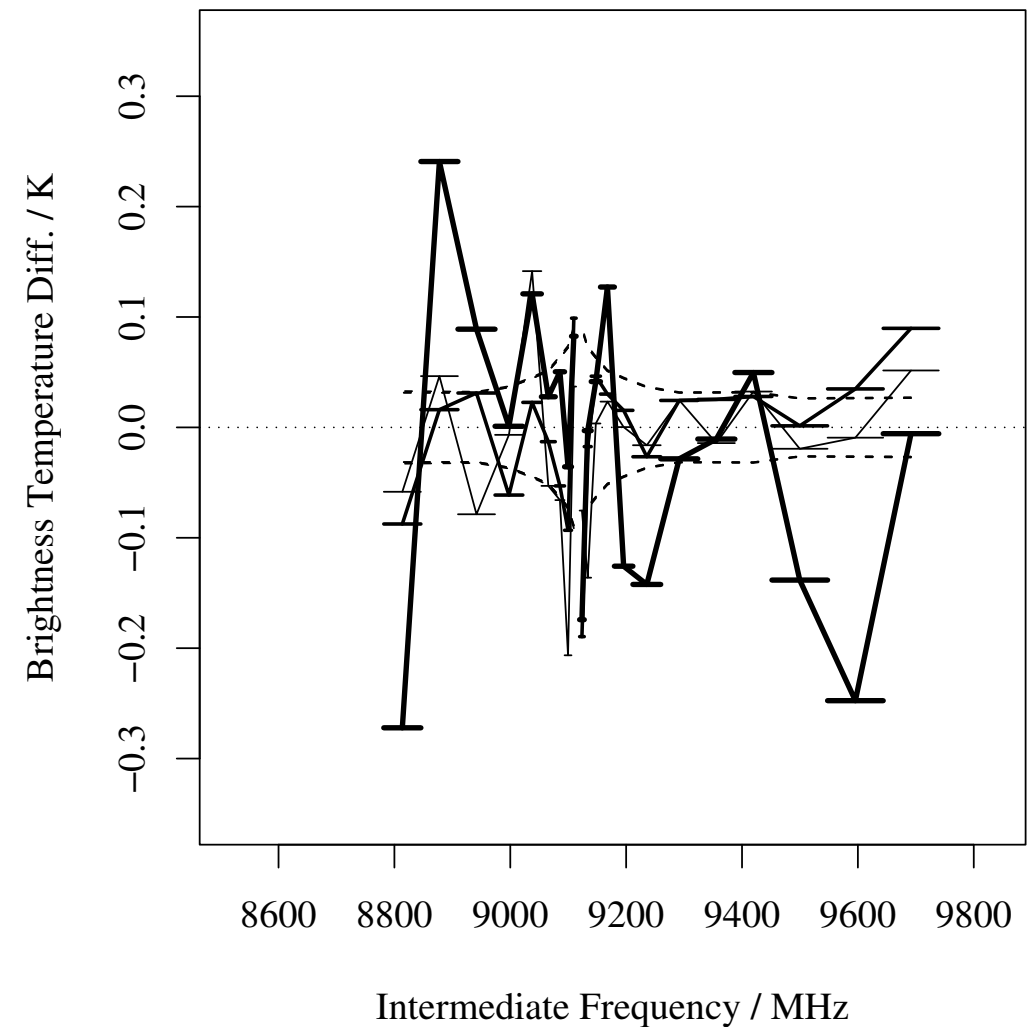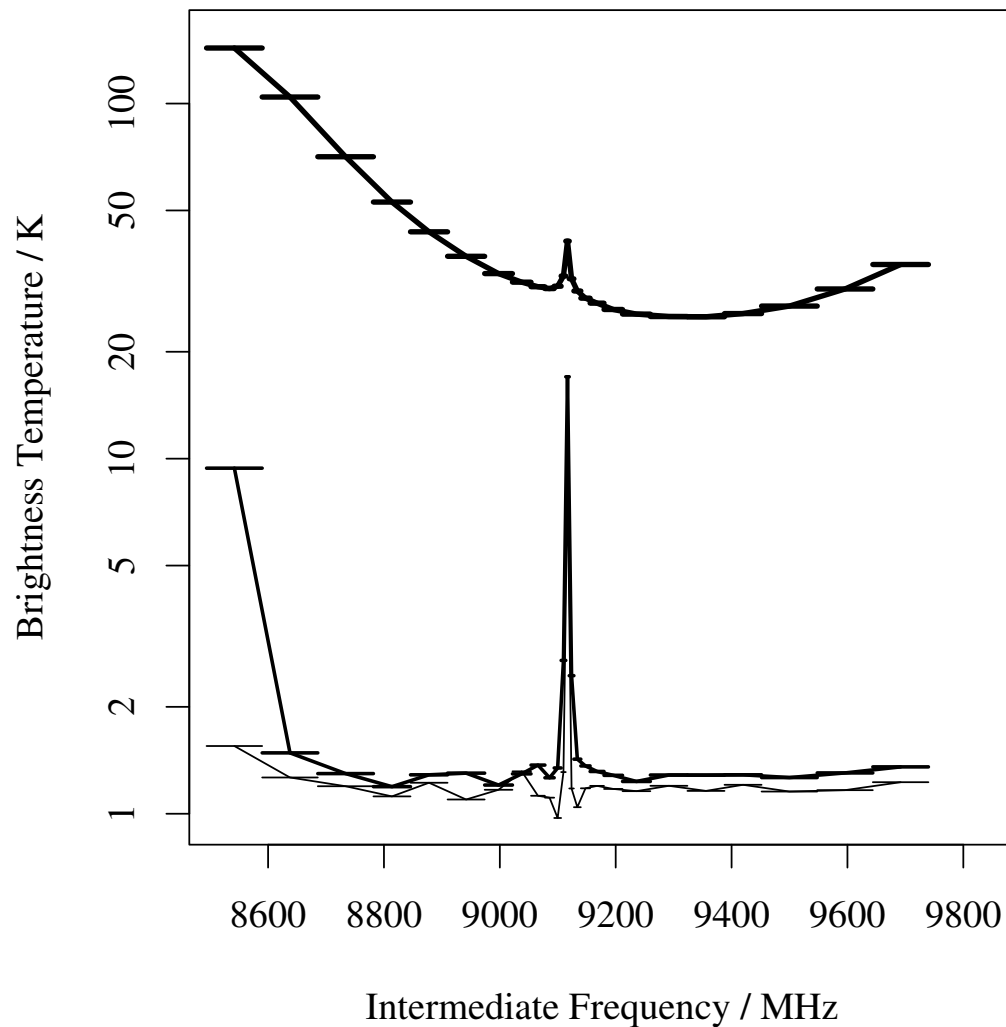

- Not all channels are used

- Tangent heights of 20, 45 and 70 km shown

- Zonal mean Residuals are MUCH smaller than measurement noise σ.

- .. but larger than $\sigma/\sqrt{n}$ (dashed line)

ZM Radiances (left) and Residuals (right): Band 25
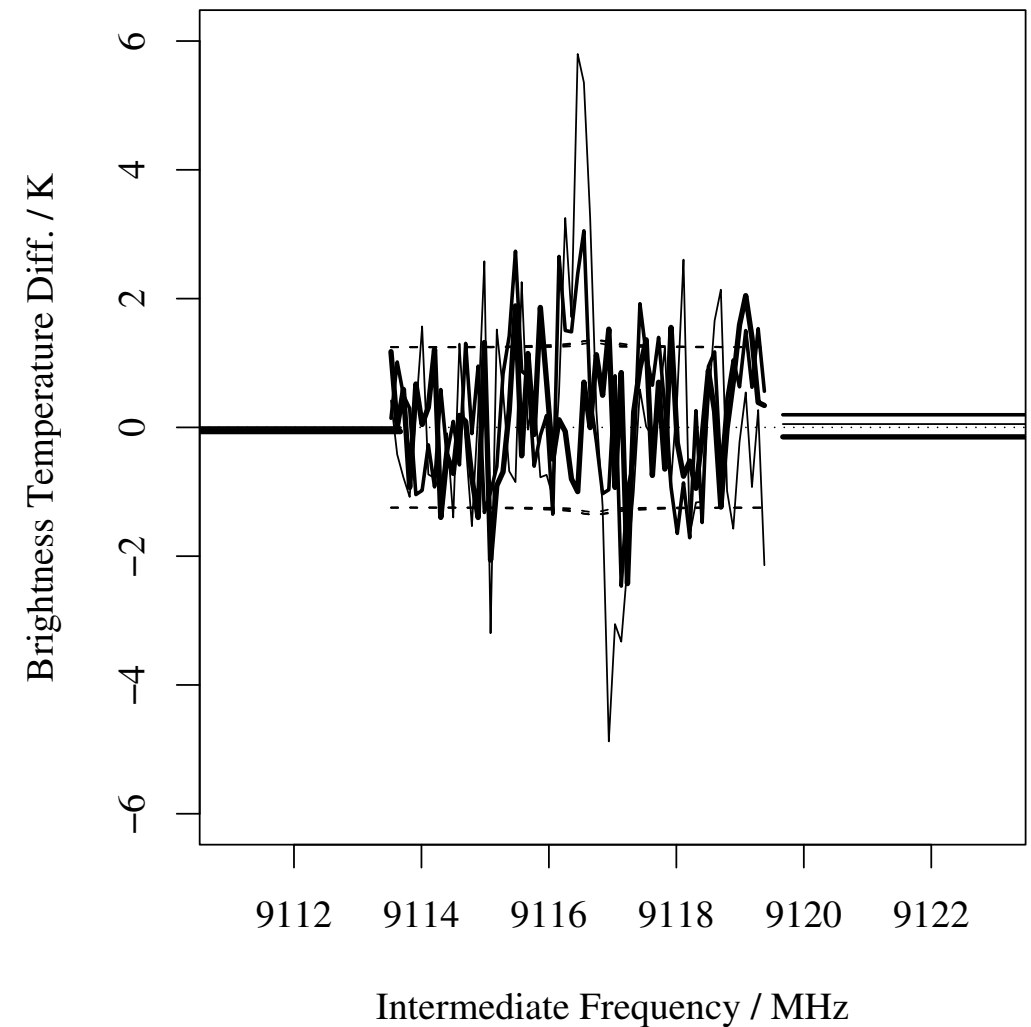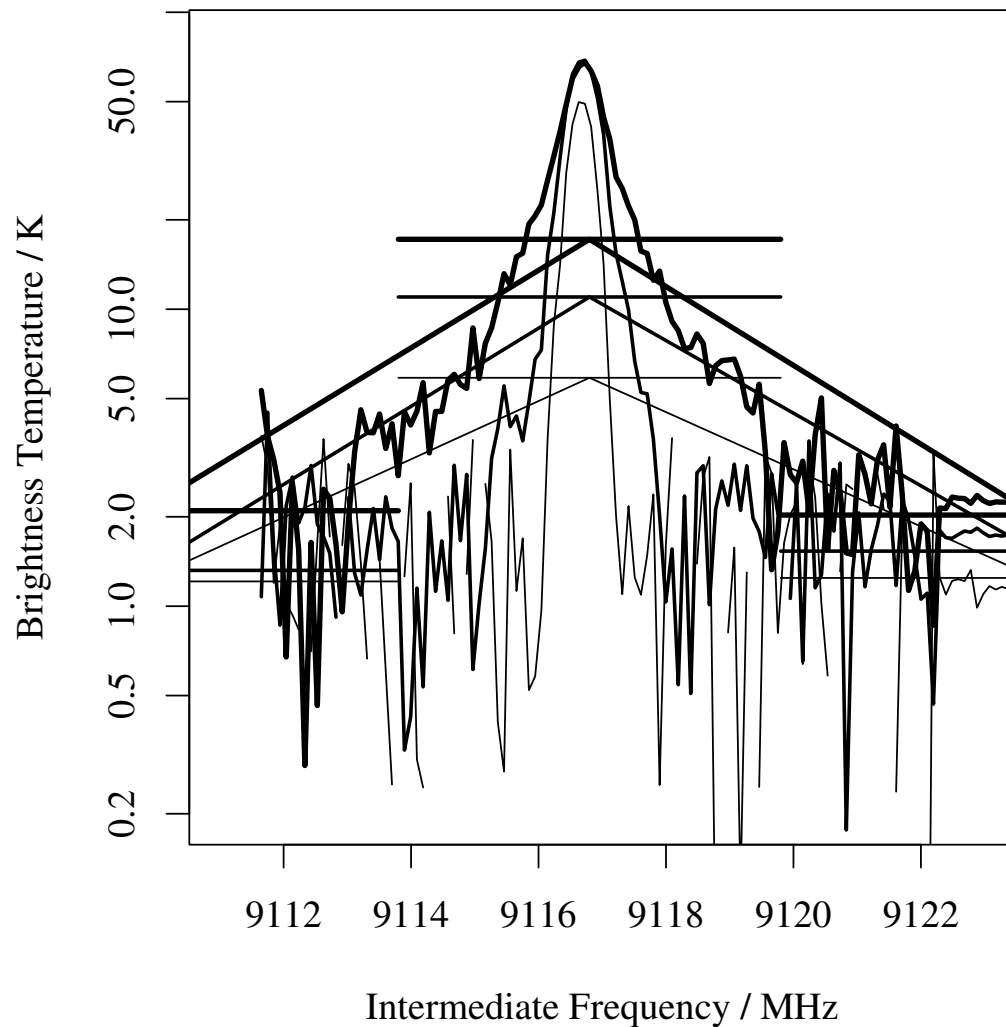
- Not all DACS channels are used

- Tangent heights of 50, 65 and 80 km shown

- Zonal mean Residuals are MUCH smaller than measurement noise σ.

- .. but larger than $\sigma/\sqrt{n}$ (dashed line) due to slight (?Doppler) line shift

CO from ACE-FTS (left) and MLS(right)
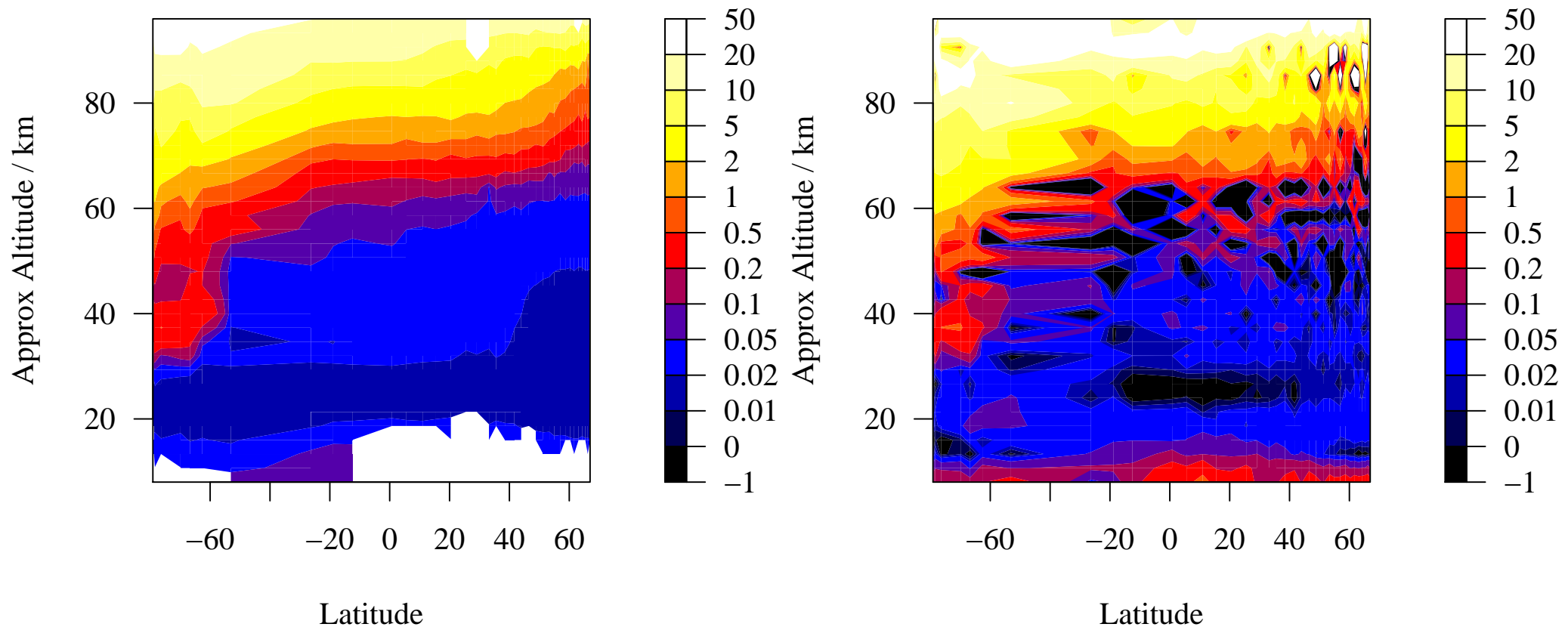
- Data are ACE daily sunset means and means of closest MLS points

- RHS of plot is 2005d195, LHS is 2005d243

- MLS data are V1.5: Note how jagged they are, but that they show the same features as ACE-FTS

- V2 will be less jagged, but we don't have enough days of it to make this plot

Comparison of V1.5 with ACE-FTS
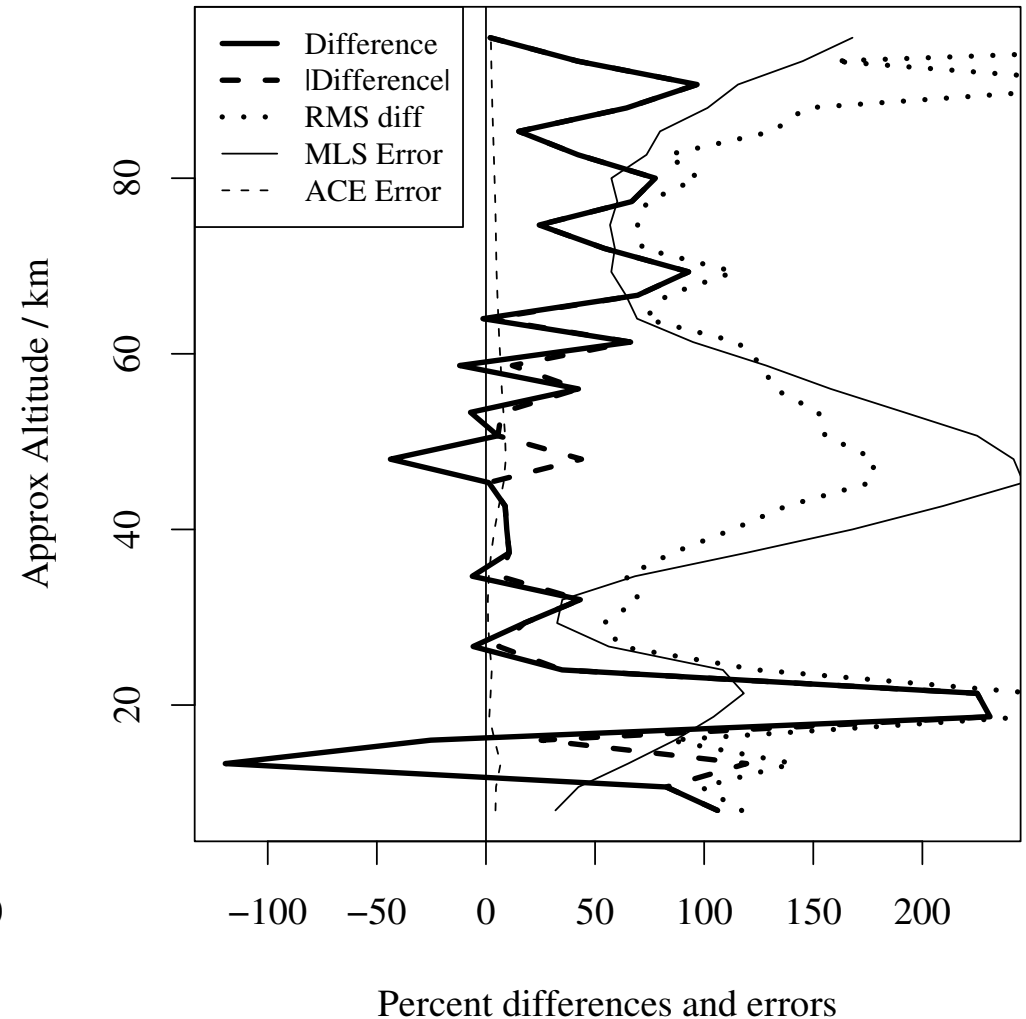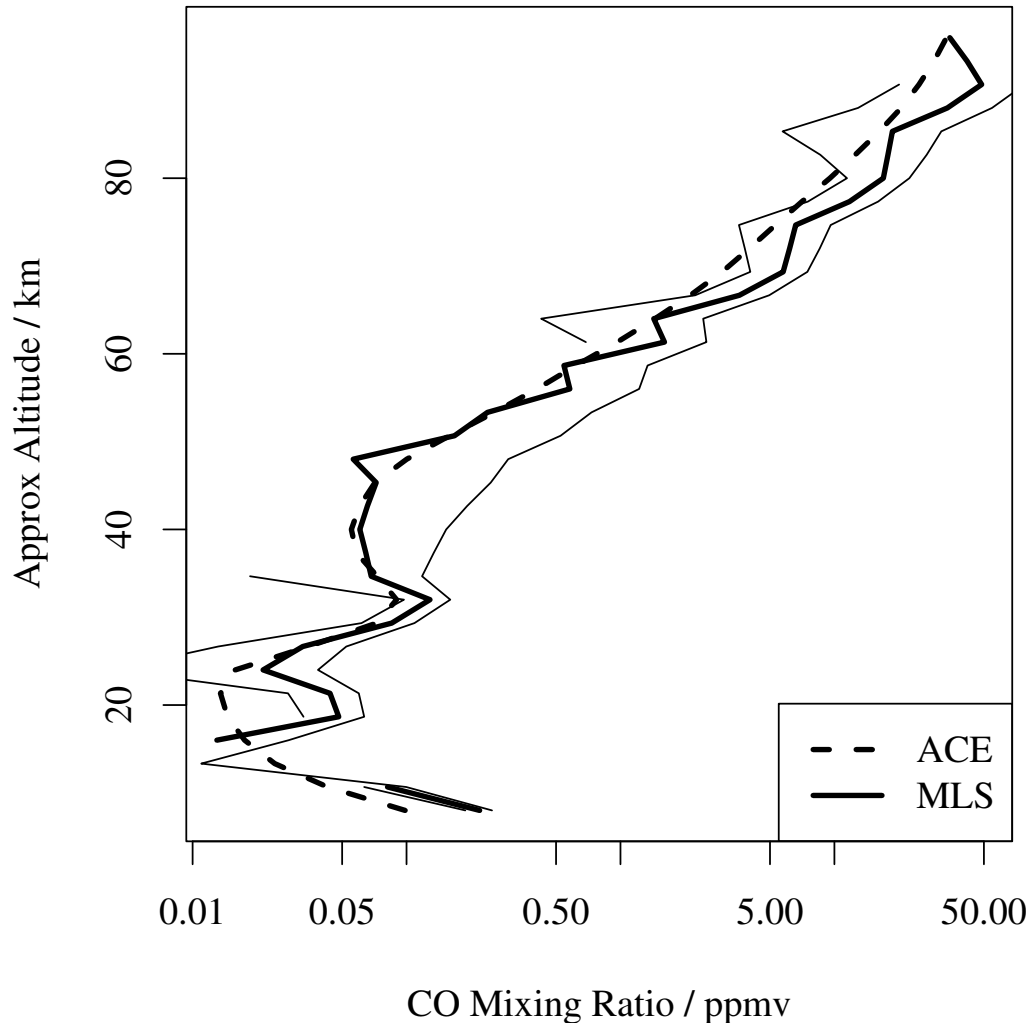
- Data are mean of all sunset coincidences between 2005d050 and 2005d075. latitudes are 73-80°N

- Bias small between 25 and 60 km, with RMS differences similar to MLS precision.

- Large bias above 60 km likely to be reduced in V2 (better handling of DACS data). Not enough V2 data to make the comparison yet.

# Comparison of V1.5 with ODIN-SMR
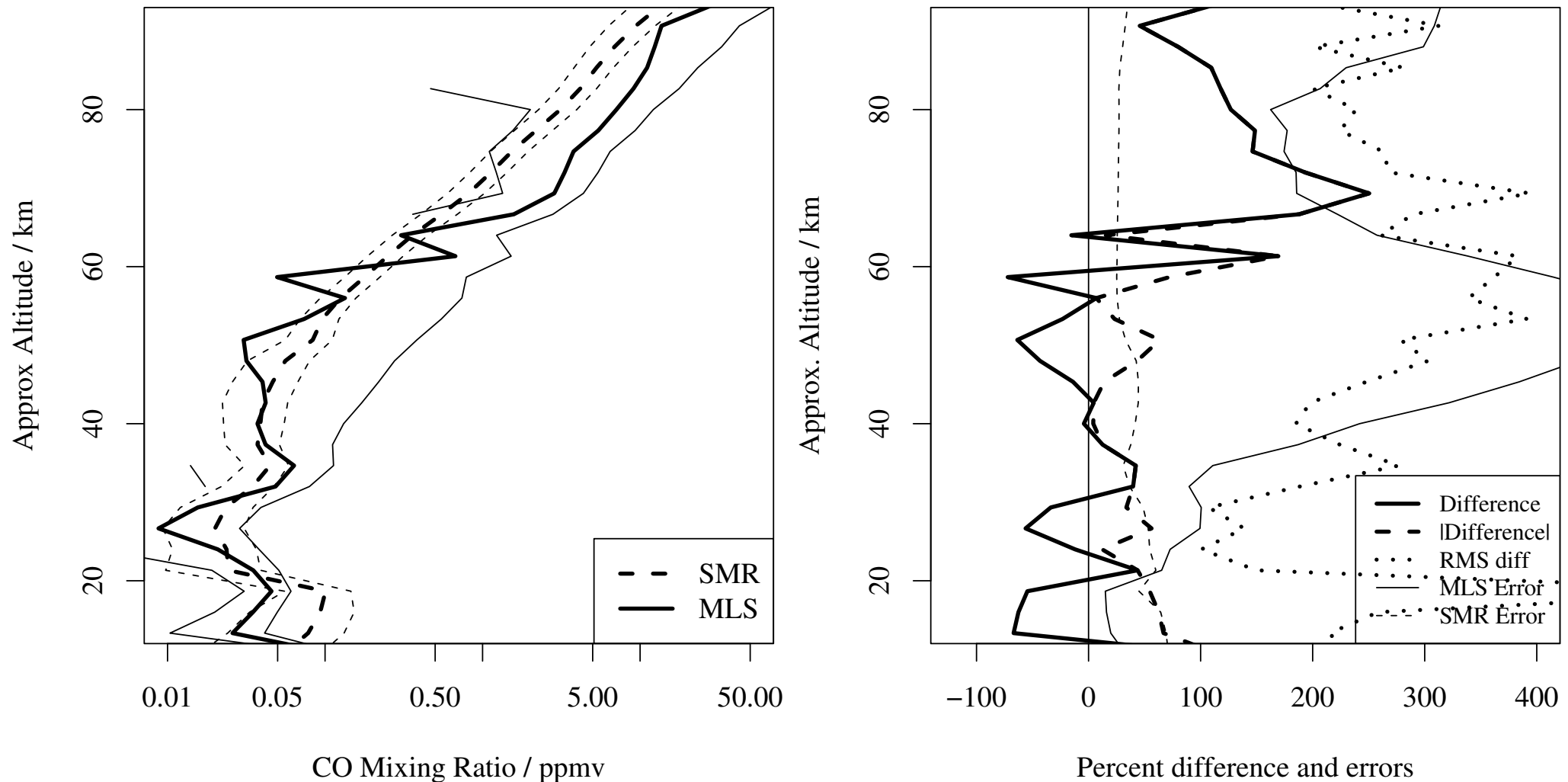
- Data are all SMR-MLS coincidences for one day (2006d022)

- Bias between 25 and 60 km small as a whole, but huge persistent zigzags affect individual levels. Zigzags will be better suppressed in V2

- Large bias above 60 km will be reduced in V2 (better handling of DACS data)

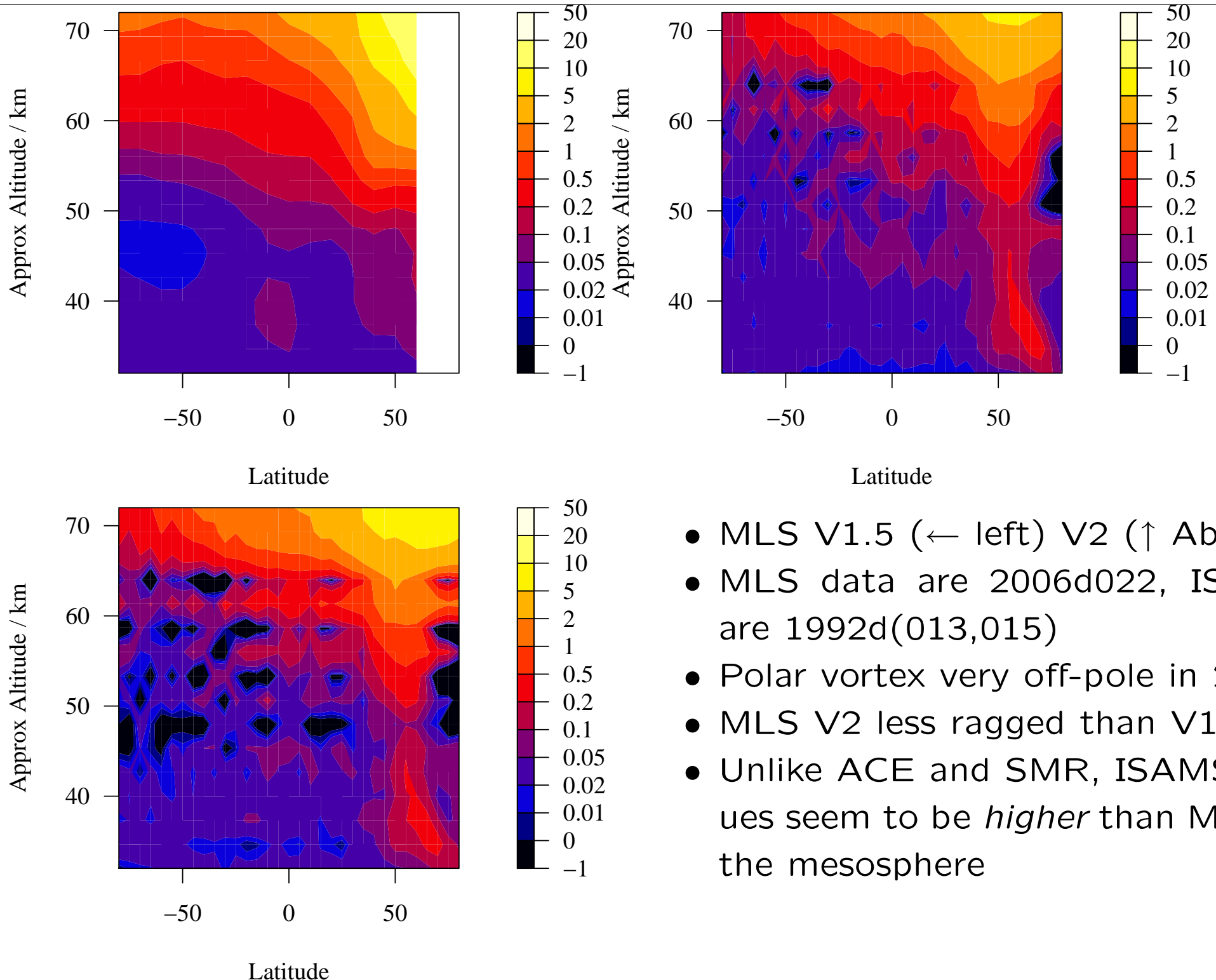# Comparison of V2 with ODIN-SMR
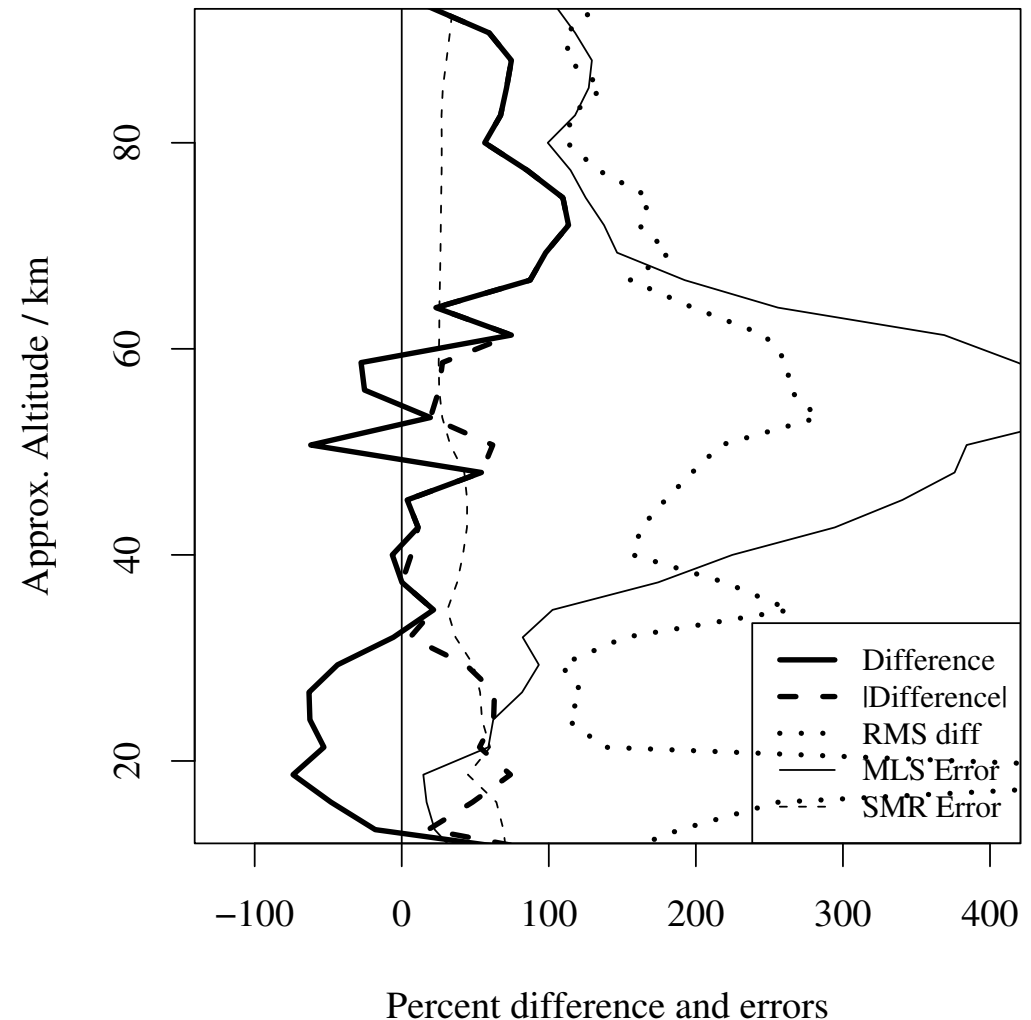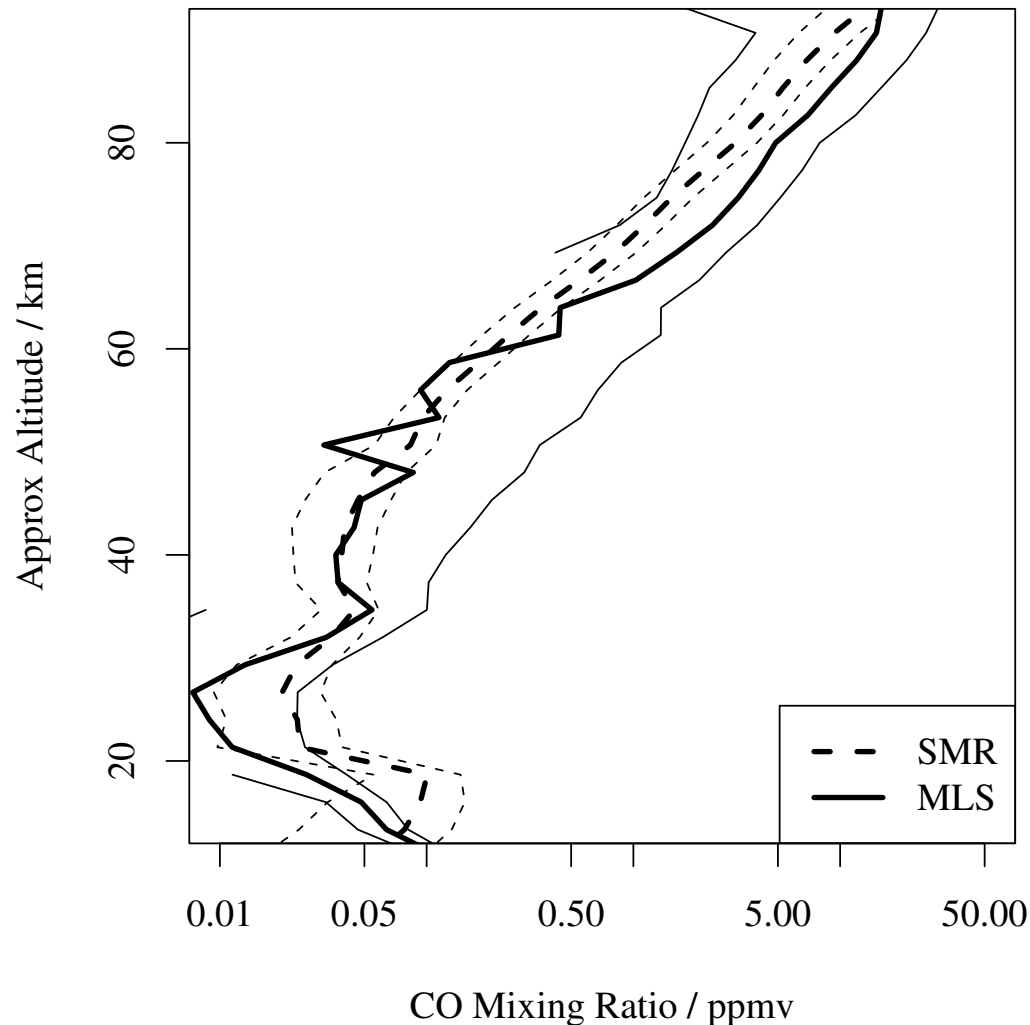
- Data are all SMR-MLS coincidences for one day (2006d022)

- Bias between 25 and 60 km small as a whole. Zigzags still present, but better suppressed than in V1.5

- Large bias above 60 km , but smaller than in V1.5 (better handling of DACS data)
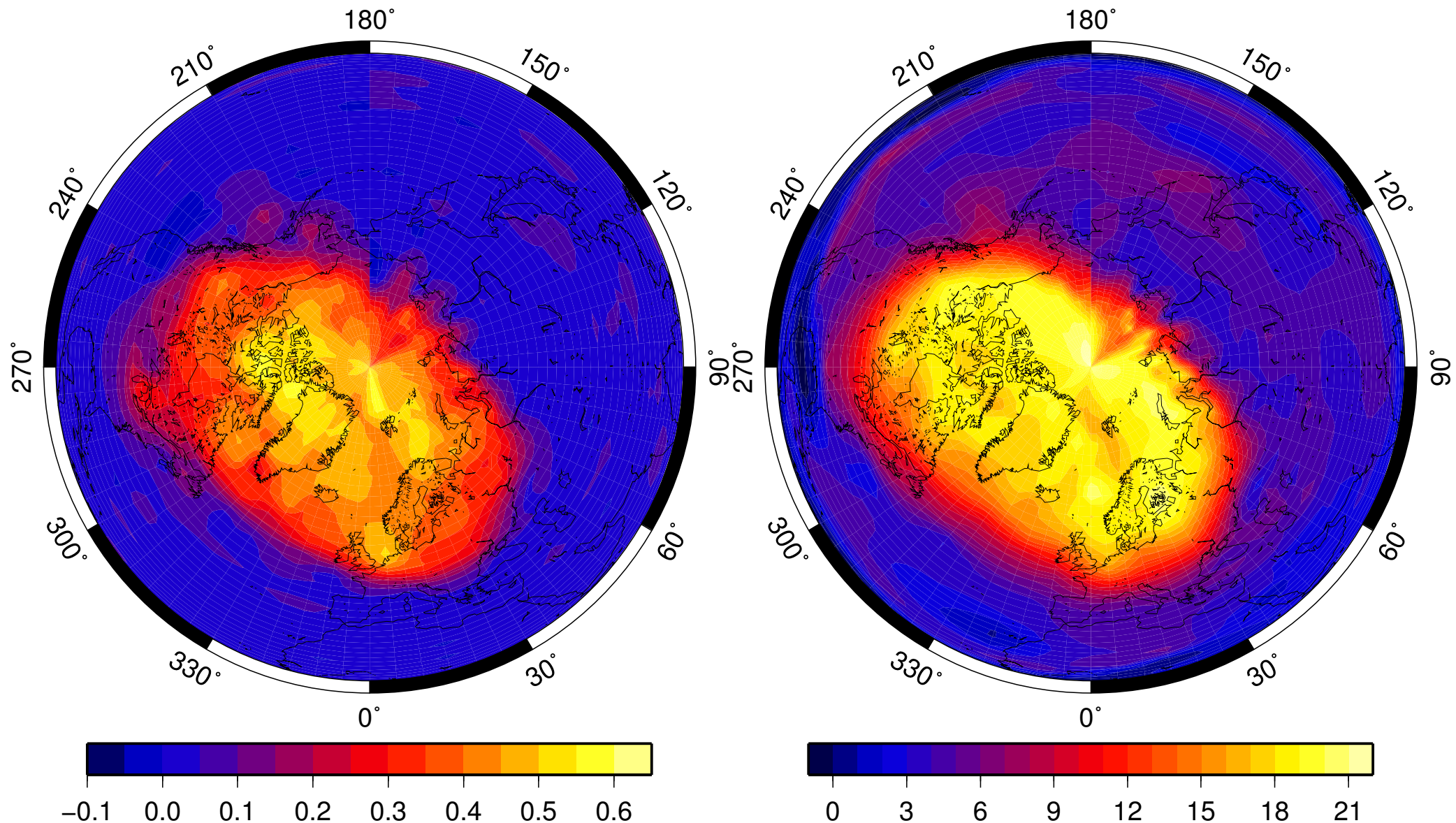
CO from UARS ISAMS (left) and EOS MLS (right)
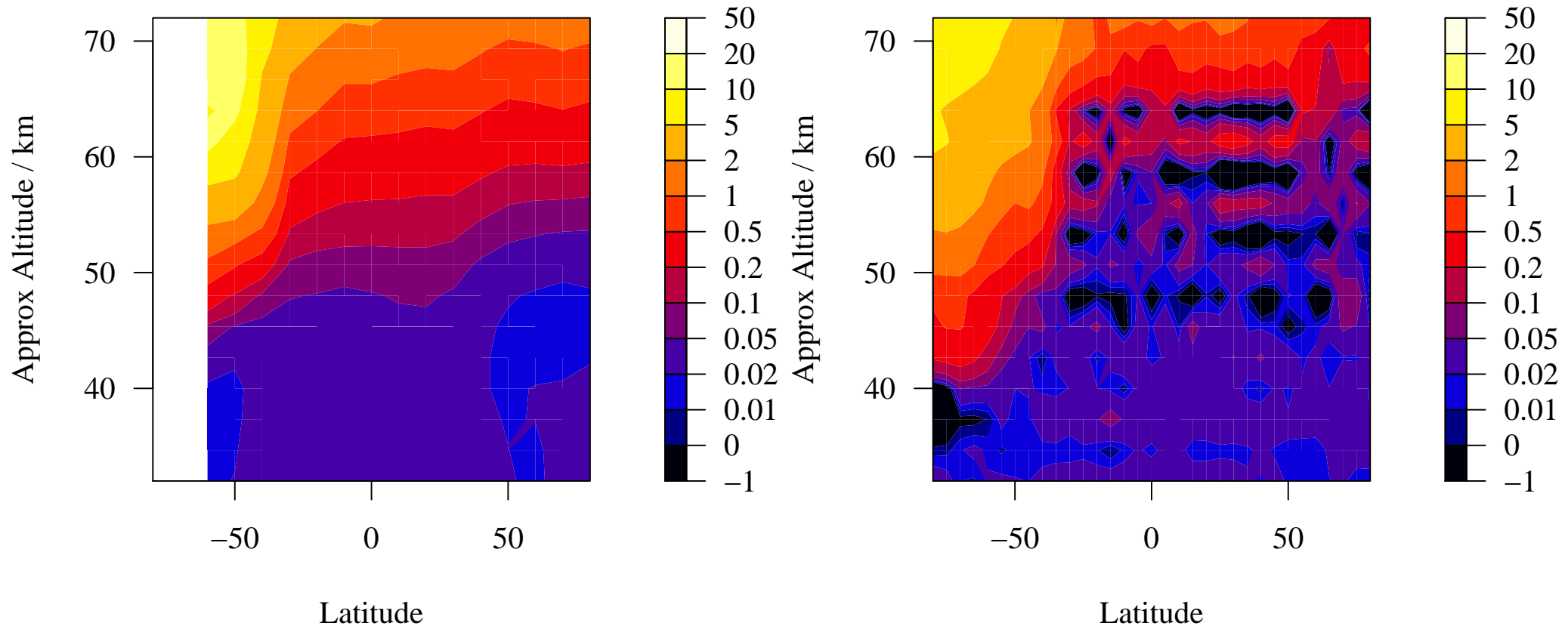
- Data are day 2006d154 for MLS, 1992d(152,154) for ISAMS)

- ISAMS data are daytime only – ISAMS could measure CO over a greater vertical range during the day

CO from UARS ISAMS (top left) and EOS MLS

- MLS V1.5 (← left) V2 (↑ Above)
- MLS data are 2006d022, ISAMS are 1992d(013,015)
- Polar vortex very off-pole in 2006
- MLS V2 less ragged than V1.5
- Unlike ACE and SMR, ISAMS values seem to be *higher* than MLS in the mesosphere

Comparison with Potential Vorticity at $\theta = 1040\,\mathrm{K}$

- LEFT: CO mixing ratio / ppmv. RIGHT: PV ($10^{-4}\mathrm{Km}^2/(\mathrm{kgs})^{-1}$) from GEOS-4

- Tight correlation between PV and CO as expected

- CO data are V2.1 for 2005d028

Summary

- Validation of MLS CO is proceeding well

- MLS CO has not sprung any scientific surprises in the middle atmosphere

- V2 will agree better with the correlative data than V1.5 does

  - Positive bias above 60 km much decreased in V2

  - Jaggedness (especially between 40 and 60 km) much reduced in V2